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ABSTRACT

This paper discusses issues connected with the reliability of the Neonatal Behavioral Assessment Scale (NBAS) in terms of behavior prediction, neonatal behavioral organization and stability, and consequent implications for study of newborns. Discussion focuses on: (1) reliability, and (2) prediction and neonatal assessment. The NBAS is seen as a basically reliable instrument, yet its predictive reliability for stability of behavior is questioned. The view that environmental influence on developmental outcome is minimal or uniform is contested. Need is seen for specifying the functional interaction between variables which determine developmental outcomes. Development of improved measures of the range and variability of neonatal behavior is discussed. It is noted that the NBAS tester is trained to elicit and score the best observable behavior, rather than the characteristic (or modal) behavior, particularly on orientation items. Possibilities for measuring discrepancies in scores between best and characteristic behavior are discussed. It is contended that the central issue in neonatal assessment is not the identification of individual temperamental characteristics, but rather the identification of environmental features which interact to produce developmental outcomes. A number of tables are included. (Author/BF)

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Stability and Instability in the Newborn Infant: The Quest for Elusive Threads[1]

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The resurgence of interest in the human newborn began almost 20 years ago. We have, in this time learned that newborns fixate visual stimuli discriminatively (Fantz, 1963), are conditionable (Siqueland and Lipsitt, 1966), respond to olfactory stimuli (Engen and Lipsitt, 1965; Self, Horowitz and Paden, 1972), process auditory information (Graham, Clifton, and Hatton, 1968), show interactive attending patterns (Stechler, Bradford, and Levy. 1966), and habituate to repeated visual stimulation (Friedman, 1972). The normal newborn thus appears on the scene equipped to interact - or, as Sameroff would have it, transact business. It is the stuff of which dynamic lectures in introductory courses are made these days. Our understanding of the newborn's competence has been augmented by an appreciation that birth is only an event on a continuum of a journey begun nine months before. This gestational course is not an isolated set of biological events but one subject as well to environmental influences mediated by the mother's behavior (Lubchenko, 1976; Miller, Hassanein & Kensleigh, In Press).

In trying to predict developmental outcomes we have continually searched for specific events that are responsible for adverse development. However, the accumulated evidence indicates that there are no simple continuities between specific events - or even constellations of events either prenatally or perinatally - and the subsequent developmental course of the infant (Sameroff and Chandler, 1975). The fall back position is socio-economic status. SES is continually invoked as functionally responsible for developmental outcomes even though SES is not a "function" but a description of complex conditions that have not lent themselves easily to causative understanding.

With the more detailed techniques available to assess newborn behavior (Self and Horowitz, In Press; Rosenblith, In Press) a beacon of hope appears to be growing that such assessments will permit us to identify continuities. However, despite the growth of our knowledge about infants it is, unfortunately true that the hope is being cast in the form of some

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old questions which one might have thought had been discarded. For example--letters arrive in my box at a steady rate which say "I understand you have done work with the Neonatal Behavioral Assessment Scale - please send a list of all pertinent references and also tell me the reliability of the scale over the first few months of life and what it predicts for later development. I want to correlate neonatal behavior with x, y, and z." I despair answering these inquires. We do have reliability data for the Brazelton over the first month of life but I really want to ask the person who wrote the letter "Why do you want to ask the questions you have posed." It is as if all the sophistication of our questions relating to possibilities for nature-nurture interactions as controlling development are forgotten in the moment of research conceptualization looking for reliability and predictability of newborn assessment techniques. This paper, therefore, is designed to answer all potential future letter writers - in public - with the goal of influencing all of us to ask questions about reliability and prediction from newborn assessment that in some way really reflects what we have learned over the past 20 years.

My plan - is as follows. I am going to talk about the issue of reliability in the Neonatal Behavioral Assessment Scale, about prediction and about behavioral organization in the newborn, its stability and the implications that these observations have for the rationales which infuse our study of the newborn. If there are some elementary comments which remind you of being back in an introductory course I apologize in advance. Any "back to basics" attempt does involve simplistic assertions - at least in the establishment of some common foundations.

Reliability

Reliability - as we all appreciate - has several definitions. The most important definition is that which relates to the ability of two independent observers at the same time recording the same observations. All training in research methodology requires this definition to obtain as a universal first step. In this regard, reliability of the Neonatal Behavioral Assessment Scale has been demonstrated though it must be said that such demonstration requires a fairly extensive and rigorous training program. Because the assessment procedure is aimed at encompassing a rather broad range of complex neonatal behaviors scoring reliability requires extended experience with the organism and some tolerance for the "art" of assessment. Nevertheless, though some of the definitions of scale score points in the manual could stand revision and though on some scale items it is more difficult to achieve reliability than on others, persistence tends to be rewarded and scoring reliability can be achieved.

Another definition of reliability involves stability. And here we can ask, are scores obtained by the infant on one day similar to the scores on

the next day, and the next, and the next? How stable is the observed behavior over what period of time. Now we have come to a data question for which we can supply some information. In one study we had a sample of 44 infants from Kansas who were repeatedly assessed once a day for the first five days of life, on Day 7, and Day 10 and at one month of age (Aleksandrowicz, 1973). In another study we had a sample of 60 Israeli infants who were repeatedly assessed once a day for the first four days of life and then again at one month of age (Horowitz, et. al., 1977). These studies involved attempts to understand the effects of obstetrical medication on the behavior of newborn infants over the first month of life. The results of the day to day reliability analysis using the Pearson r are shown in Table 1 with I designating the significant correlations obtained on the Israeli sample and K for those obtained on the Kansas sample. By 5% chance we would expect about 10 significant correlations from the Israeli sample; the analysis yielded 79 significant correlations. By 5% chance on the Kansas sample we would expect about 27 significant correlations; the analysis yielded 35 such correlations. There were far fewer significant correlations in the Kansas sample than in the Israeli sample. Does this mean that Israeli newborns are more behaviorally stable than Kansas newborns? Perhaps. What factors might account for this difference? One possibility is that in the Kansas sample obstetrical medication was used more heavily and had a greater effect on behavioral variability. In the Kansas sample no obstetrical medication was used with only five infants; in the Israeli sample half the sample (30 of the 60) were born without the use of any obstetrical medication. Further, there is some indication that the Israeli infants, minimally affected by obstetrical medication also had behavioral repertoires at birth closer to asymptote on the NBAS items.

On the basis of these data what might one conclude? Day to day reliabilities on the Kansas sample were not high or abundantly significant; on the Israeli sample they were more abundant as to significance though in absolute levels they were not overly impressive. Where does this leave us? Well - looking differently at our data. Tables 2 and 3 illustrate another evaluation of stability. Here we have taken each infant's protocol and evaluated it by infant. A score for two days was counted as reliable or "in agreement" if the score was exactly the same or different by only one point. It is clear in reviewing Tables 2 and 3 that in this accounting both the Israeli and the Kansas infants show considerably more stability, over-all, in behavioral profile than does any single item for day to day comparisons. The Israeli sample's stability is slightly higher. Do we have confidence in more stability over the first month of life? Should that make us happy? We'll see.

I would argue that while relative rank order (the Pearson r analysis) is a perfectly viable statistical concept, it is not a viable functional concept for helping us to understand how development happens. Development,

I will argue, if it results from an interaction of individual and environment, ought to result in relative instability of those individual characteristics that are subject to environmental impact. If we think experience makes a difference we can only predict outcome when we can measure the intial behaviors of the organism and can either pre-measure the experience to come or can specify how different experiential components will interact with intial behaviors to result in particular developmental outcome.

But, you might argue - isn't day to day reliability in the very first four days of life a rather minimal kind of stability to expect if the behavioral measures are to be useful? (I might ask you useful for what but will refrain for the moment). You might also argue that even if one accepts the impact of experience as providing the basis for instability surely the amount of functional experience occuring in the first four days ought not to be that massive as to immediately produce the kind of environmentally determined instability one is talking about. Isn't, you might continue, the behavioral repertoire of the newborn somewhat robust? And, I would answer - yes - the robustness is demonstrable for each individual in that a generally similar profile is obtained over the first few days. There is some hint of the differential stability between American and non-American samples has been replicated in an analysis reported by Super (1973) comparing a sample of American infants with a sample of Greek infants. He demonstrated a much more similar correlation structure in repeated testing of Greek infants on Days 1, 5, and 10 than found with American infants on similar test days. Super attributed the difference to the more heavily medicated nature of the American sample but I also suspect that the Greek sample, like our Israeli sample was probably much more homogenous on other grounds as well.

In terms of reliability we stand as follows: Tester or scoring reliability at the same examination is achievable with sufficient training and tolerance for interpretation beyond the literal meaning of the scale score definitions; day to day reliability over the first four days is moderate to low on most of the individual items though individual infants show moderate overall stability with respect to their overall performance. Additionally there is a somewhat consistent factor structure in the neonatal repetoire. Ought we to be discouraged or encouraged?

This leads us to a critical analysis of why we are interested in a stable measure of neonatal behavior. The old psychometric motivation was long term prediction and neonatal assessment is, in many ways, still infected with this rather misguided criterion. For the purpose of stimulating controversy here let me make a stronger statement than one might otherwise wish to defend. The only reason for expecting long term prediction from neonatal assessment is believing or placing one's bets on

hypothesizing that the influence of environmental factors on developmental outcome is likely to be minimal or so uniform as to function as a constant. If one views development as an interactive or transactive process and if one cannot now specify the values of the environmental factors involved in this process, prediction is not only not possible, it is not a valid criterion for judging the utility of neonatal assessment. This brings us to a nature and nurture formula in which the challenge is not only to make reliable measurements at any point in time but to specify how the measures change and to specify the functional interaction between variables which determine developmental outcome. Such a position, taken seriously, does not result in being discouraged by lack of test-retest reliability. It ought to result in influencing us to cast our questions in researchable lights which approximate the enormous complexity of the phenomena with which we are dealing.

Prediction and Neonatal Assessment

Let us turn then from the issue of reliability to the matter of prediction and neonatal assessment. How do we tap in on the behavioral repertoire of the newborn infant? The Neonatal Behavioral Assessment Scale is an attractive instrument partly because it elicits a very wide variety of infant behaviors to which the mother or the primary caretaker is likely to be responsive. Osofsky and Danzger (1974) and Strauss (1976) have reported validation of the assessment procedure for discriminating newborns in interaction with their mothers. Osofsky (1976) has recently elaborated upon her earlier findings and presents some provocative new data. Mother-infant interaction during a feeding situation was related to the behavior assessed in the Neonatal Behavioral Assessment examination; but a structured mother "stimulation of the infant" situation in which the mother was asked essentailly to do some of the things that the examiner does when making the formal assessment, was not related to the Neonatal Behavioral Assessment Scale scores. Further, the better the mother was in presenting the "items" as instructed to her infant the better the infant's response to the items. What Osofsky does not note is that indeed, the Neonatal Behavioral Assessment tester is trained exactly in that fashion - to develop the best possible technique for eliciting the best behavior from the infant. And herein lies an important strategy issue and one which I believe may be very fruitful. It relates to trying to develop some better measures of the range and variability of the newborn's behavioral repertoire. Our first, and somewhat simple notion had to do with cueing in on the fact that in the NBAS we are trained to elicit and to score the very best behavior we can observe - especially on the orientation items. So, in a master's thesis attempt Jean Dempsey set out to score, as well, what we called the infant's characteristic behavior on the orientation items and to see if we could derive a discrepancy score between the best and the characteristic behaviors which might prove to be useful data about the

infant. The attempt did not come off very well for several reasons. We found that on a nine point scale, especially where the lower end points are rarely used, our discrepancy scores were rather minimal leaving little range for any kind of meaningful analyses. We decided also that the notion of "characteristic" behavior carried with it too much surplus meaning. Still, there was an intuitive appeal to the original attempt. So, we have persisted. We are now beginning to collect data on a sample of normal newborns scoring the best and what we have labeled the "modal" behavior on the orientation items and some others - and summing across the orientation items for a sum "modal" and a sum "best" score and deriving an overall discrepancy score from those sums. If such a tactic gives enough variability then we will be able to elaborate the strategy to looking at mother-infant interaction patterns and, as well, general patterns of stimulation available to the infant from other environmental sources. Our plan calls for a study of normal and risk infants.

A second question that needs to be raised with regard to neonatal assessment has to do with the use of individual difference information which some people are calling "temperament". Here again, there is lurking in the back of many discussions the standard psychometric criterion - predictability. Specify the given temperamental qualities early enough and surely enough and we will PREDICT developmental outcome. Why? Isn't this another way of stating the hope that environmental events are really irrelevant - that the signal to noise ratio will be drastically reduced if only we can tap the real nature of the newborn? The issue, I would contend, is not the identification of individual temperamental characteristics to better enable us to predict the steady signal detectable throughout development as the parametric controlling feature - but rather to tap in on the newborn behavioral repetoire in such a way that we can most fruitfully identify the environmental features which interact in describable ways to produce developmental outcome. Behavioral organization in the newborn infant - or even disorganization - is a datum to be entered into the equation. Admittedly the complexity of our task is made greater by the fact that we not only don't know the form of the equation but we are not now sure which and how many variables need to be accounted for. While there is an increasing appreciation of the fact that caretaker and infant mutually influence each other (Lewis and Rosenblum, 1974) our net is probably not yet wide enough in relation to what we need to account for. For instance, there are possibilities to be entertained: the mother and infant influence each other. But, is this mainly in the moment of their interaction or in service of influencing eventual developmental outcome? In what ways do we define developmental outcome? Much of our energies have focused upon intellectual and cognitive measures. Spurred by the major SES correlations and the suspicion that lodged in those SES correlations are the functional interactions between caretaker and infant which make the differences - we look at mother-infant

interaction in order to illuminate the process of cognitive and intellectual achievement. Yet, perhaps it is in the realm of social and affective achievements that mother-infant interaction makes the most difference; cognitive outcome criteria may be much more closely related to individual differences in stimulus and information processesing related to amount, kind, density, and variability of non-social environmental stimulation. That the newborn is clearly a functioning processor of stimulus information was one of the observations with which we began and to which I would like to return in closing. We have developed some very significant techniques for assessing the behavioral repertoire of the newborn infant. Between the testing evaluations of the Neonatal Behavioral Assessment Scale and the Graham/Rosenblith Scale and the experimental laboratory techniques of Fantz, Lipsitt, and others the newborn's behavioral repetoire is fully available to us for display, measurement, and evaluation. But, our progress now depends more upon keeping before us the widest set of possible options with regard to possible models for describing the developmental process.If we trap ourselves too fully into the standard psychometric criteria for evaluating our successes and failures we will probably lose the opportunities that are before us. If we discard our techniques because they fail to give us day to day reliability we may be discarding some very important entres into increasing our understanding of the processes involved in development. If we are serious about believing the data that point more and more toward the tremendously complex nature of the infant interacting with the environment - or transacting business - then we must accept test-retest unreliability when it occurs as data - and not dismiss it as error. The remainder of the commentary should follow in your own head today, tomorrow, and in the months and years you have to think about this. My only final observation is that whether or not I have convinced you, I now have, as a result, a paper which I can routinely send to those who write and ask me for the information I have about the reliability of the Neonatal Behavioral Assessment Scale.

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TABLE 1

Israeli and Kansas Infants (I, K)
Significant NBAS Reliabilities

Scale Item	Day 1 & Day		Day 2 & Day		Day 3 & Day		Other-Days-Day	
5.Inan. Visual	2.	.34 I	3	.35 I				
	3.	.34 I	4	.34 I				
	2	.34 K	1mo.	.34 I				
	4	.49 K						
6.Inan. Aud.	2	.30 I			1mo.	.22 I		
7.Anim. Visual	2	.28 I	3	.22 I			4-5	.39 K
	3	.34 I	4	.44 I			4-7.	.38 K
	4	.34 I					7-10	.49 K
	2	.50 K						
	3	.37 K						
	4	.35 K						
8.Animate-Audit.	2	.37 I						
	3	.30 I						
9.Anim Vis. & Aud.	2	.24 I	3	.32 I	4	.36 I	1-5	.35 K
	3	.27 I	4	.34 I	4	.41 K	3-5	.33 K
	4	.27 I						
	2	.43 K						
	3	.43 K						
10.Alertness	3	.28 I	3	.45 I	4	.28 I		
	4	.35 I			4	.52 K		
11.Tonus	2	.41 I	3	.30 I				
	3	.30 I	4	.25 I				
	4	.45 I						
12.Motor Matur.	2	.27 I	3	.28 I	4	.22 I	4-1mo.	.39 K
	4	.39 I						
13.Pull to Set	4	.26 I	3	.40 I	4	.24 I		
	1mo.	.38 I			4	.38 K		
14.Cuddliness	2	.24 I	3	.34 I	1mo.	.23 I	4-5	.46 K
	3	.21 I	4	.26 I				

TABLE 1

continued
-2-

15. Defensive Movement	2	.32 I	3	.38 I	4	.41 I		
16.Consolability	2	.24 I	3	.24 I				
17.Peak of Excitem.	2	.33 I	1mo.	.30 I	4	.47 I	1-7 3-10 4-10	.46 K .52 K .48 K
18.Rapid Bld.-Up.	2	.41 I			4	.26 I		
19.Irritability	2 3	.33 I .33 I	1mo.	.22 I	4	.24 I		
20.Activity	2 3 4	.36 I .26 I .24 I						
21.Tremulousness	2 3	.28 I .36 I	3 4 1mo.	.50 I .27 I .35 I	4 1mo. 4	.40 I .26 I .30 K	3-10 4-10 5-10	.39 K .40 K .48 K
22.Startle	4 1mo.	.23 I .29 I	1mo.	.23 I	4	.23 I		
23.Lability of Skin Color	3 2 3	.35 I .51 K .37 K	3 4	.30 I .32 I	4	.65 K		
24.Lability of States	2 3 2	.23 I .46 I .41 K	3	.25 I	4	.39 I	1-7 2-10 4-5 4-10 4-1mo. 5-10 7-10	.36 K .43 K .32 K .46 K .38 K .39 K .46 K
25.Self Queeling	2	.22 I			4	.27 I		
26.Hand to Mouth	3 4	.31 I .26 I	3 4 1mo	.31 I .32 I .23 I	4	.21 I		

TABLE 2

Kansas Sample (n= 44) NBAS day to day reliabilities for each subject using $\frac{A}{A+D}$ formula - same score or adjacent score-selected comparisons

Days	1-2	1-3	1-4	2-3	3-4	4-5	4-7	4-1mo	5-7	7-10	7-1mo	10-1mo
Mean	.53	.51	.50	.53	.55	.53	.52	.44	.55	.57	.48	.54
Range	.82-.37	.78-.22	.78-.20	.81-.31	.87-.33	.87-.26	.83-.12	.73-.23	.81-.24	.75-.26	1.00-.18	.86-.33

TABLE 3

Israeli Sample (n= 60) NBAS day to day reliabilities for each subject using $\frac{A}{A+D}$ formula -- same score or adjacent (excluding habituation items).

Days	1-2	1-3	1-4	1-1mo	2-3	2-4	2-1mo	3-4	3-1mo	4-1mo
Mean	.65	.61	.61	.56	.69	.69	.61	.65	.58	.58
Ranges	.87-.30	.83-.21	.89-.26	.82-.30	.91-.47	.91-.39	.87-.33	.91-.33	.83-.12	.87-.21

TABLE 4

First Two Factors and Loadings by Day for Israeli Sample

Factor I State Control

	Day 1			Day 2			Day 3			Day 4			Day 5	
16	Consol	-.67	16	Consol	-.80	16	Consolab	-.43	10	Alert	-.54	1	Habit Light	.39
17	Peak Exc	.87	17	Peak Exc	.85	17	Peak Exc	.83	11	Tonus	.42	2	Habit Rattle	.33
18	Rapid Bldup	.80	18	Rapid Bldup	.71	19	Irrit	.86	16	Consol	-.36	16	Consol	.80
19	Irrit	.88	19	Irrit	.84	20	Activity	.36	17	Peak Exc	.87	17	Peak Exc	-.72
20	Activity	.41	24	Lab State	.64	23	Lab Skin	.51	18	Rapid Bldup	.71	18	Rapid Bldup	-.84
21	Tremul	.39	25	Self-Quiet	-.82	24	Lability St	.81	19	Activity	.62	19	Irrit	-.88
24	Lability St	.88				25	Self Quiet	-.48	24	Lability St	.88	24	Lability St	-.85
25	Self Quiet	-.60				27	Smiling	-.30	25	Self Quiet	.68	25	Self Quiet	.33

Factor II Orientation and Attention

	Day 1			Day 2			Day 3			Day 4			Day 5	
5	In Vis	.73	5	In Vis	.74	5	In Vis	.73	5	In Vis	.52	1	Hab Light	.68
6	In Aud	.82	6	In Aud	.87	6	In Aud	.76	6	In Aud	.53	3	Hab. Bell	.57
8	An Aud	.62	7	An Vis	.37	7	An Vis	.59	7	In Vis	.88	8	An Aud	.31
9	An V & A	.32	8	An Aud	.83	8	An Aud	.74	8	An Aud	.33	11	Tonus	.54
10	Alertness	.69	9	An V & A	.33	9	An V & A	.53	9	An V & A	.90	13	Pull to Sit	.48
15	Defen Mov	.51	10	Alert	.69	10	Alertness	.69	10	Alertness	.67	20	Activity	.79
			12	Motor Mat	.34	27	Smiling	.36	15	Def Movem	.42	26	Hand Mouth	.35
									20	Activity	.42			
									25	Self Quiet	.31			

TABLE 5

First Two Factors and Loadings by Day for Kansas Sample
Factor I Orientation and Attention

Day 1			Day 2			Day 3			Day 4			Day 5		
5	In Vis	.85	5	In Vis	.82	4	Pinprick	-.42	5	In Vis	.76	5	In Vis	-.30
6	In Aud	.41	6	In Aud	.74	5	In Vis	.87	6	In Aud	.65	6	In Aud	-.38
7	An Vis	.90	7	An Vis	.94	6	In Aud	.32	7	An Vis	.88	14	Cuddliness	-.49
9	An V&A	.90	8	An Aud	.42	7	An Vis	.92	8	An Aud	.77	16	Consol	-.90
10	Alertness	.68	9	An V&A	.95	8	An Aud	.46	9	An V&A	.91	17	Peak Exc	.87
11	Tonus	.55	10	Alertness	.82	9	An V&A	.90	10	Alertness	.76	18	Rapid Bldup	.75
24	Lability St	.43	11	Tonus	.35	10	Alertness	.75	13	Pull to Sit	.36	19	Irrit	.58
									17	Peak Exc	-.59	27	Smiling	.38

Factor II

Day 1			Day 2			Day 3			Day 4			Day 5		
1	Hab light	.43	8	An Aud	-.78	16	Consol	-.50	2	Hab Rattle	-.30	1	Hab Light	.32
2	Hab Rattle	.83	12	Motor Mat	-.45	17	Peak Exc	.76	4	Pinprick	.39	3	Habit Ball	-.36
3	Hab Bell	.86	20	Activity	-.46	18	Rapid Bldup	.82	17	Peak Exc	.42	11	Tonus	.90
4	Pinprick	.62	22	Startle	.47	19	Irrit	.90	18	Rapid Bldup	.82	13	Pull to Sit	.30
13	Pull to Sit	.32				23	Lability Skin	.30	19	Irrit	.89	14	Cuddliness	-.38
22	Startle	.35				27	Smiling	.69	27	Smiling	.47	27	Smiling	.30
26	Hand-Mouth	-.38												